Attorney Docket No. USA.353 **PATENT**
Confirmation No. 6650

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Bettina Steinmann
Serial No.: 10/644,299
Filed: August 19, 2003
For: Nanoparticle-Filled Stereolithographic Resins

Group Art Unit: 1732
Examiner: Leo B. Tentoni

SEPTEMBER 18, 2006

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
Alexandria, VA 22313-1450

APPEAL BRIEF UNDER 37 CFR § 41.37

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences," filed by facsimile on May 17, 2006.

1. ***Real Party in Interest.***

The real party in interest in this appeal is 3D Systems, Inc., the assignee of the above-referenced patent application.

2. ***Related Appeals and Interferences.***

There are no related appeals and/or interferences involving this application or its subject matter.

3. ***Status of Claims.***

The present appeal involves Claims 1-21, which are currently under final rejection as set forth in the final Office Action mailed February 15, 2006. Claims 22-42 are withdrawn. The claims at issue, namely, Claims 1-21, are set forth in the attached Claims Appendix.

4. ***Status of Amendments.***

A final Office Action was mailed February 15, 2006, finally rejecting pending Claims 1-10 and 12-21 under 35 USC § 102(b), claims 1-21 under 35 USC § 102(e), and claims 1-21

under 35 USC § 103(a). Applicants did not submit any claim amendments after this final Office Action.

5. ***Summary of Claimed Subject Matter.***

The present invention relates to stereolithographic processes for forming three dimensional articles. Typically in stereolithography, portions of an upper surface of a liquid radiation curable resin in a vat are selectively exposed to radiation (for example, using a laser) to harden the exposed portions. A new uncured resin layer is then formed on the cured layer, for example by lowering a platform into the vat of liquid to allow fresh resin to flow onto and cover the cured resin layer. Thereafter, portions of the subsequent layer of resin are selectively exposed to radiation to cure the layer of resin and adhere the layer to the previously exposed imaged portion. These steps can be repeated as desired to build the three dimensional article.

The claimed invention recites a stereolithographic process for making three dimensional articles using a liquid radiation curable composition. The composition includes at least one filler comprising silica-type nanoparticles suspended in the liquid radiation curable composition. Reference is made to page 6, lines 12-15, of the present application, which defines the nanoparticles as having an average particle size ranging from about 10 to about 999 nm.

The stereolithographic process of the claimed invention includes the steps of: (a) coating a thin layer of the liquid radiation-curable composition onto a surface; (b) exposing the thin layer imagewise to actinic radiation to form an imaged cross-section, wherein the radiation is of sufficient intensity to cause substantial curing of the thin layer in the exposed areas; (c) coating a thin layer of the composition onto the previously exposed imaged cross-section; (d) exposing the thin layer from step (c) imagewise to actinic radiation to form an additional imaged cross-section, wherein the radiation is of sufficient intensity to cause substantial curing of the thin layer in the exposed areas and to cause adhesion to the

previously exposed imaged cross-section; and (e) repeating steps (c) and (d) a sufficient number of times in order to build up the three-dimensional article.

In various embodiments of the invention, the composition can include, among other components, at least one hydroxyl-functional compound. The hydroxyl-functional compound can be, for example, trimethylol propane, and further can constitute about 1% to about 10% by weight of the total liquid radiation-curable composition. See claims 18-21.

In another embodiment of the invention, the liquid radiation curable composition can include nanoparticles and microparticles. See claim 21.

As discussed on page 5, lines 12-20, of the present application, the resins including silica-type nanoparticles can exhibit various advantages over other filled stereolithographic resins. As an example, the resins as claimed can be optically transparent because of the small size of the particles, and therefore may not scatter light so that the resolution can be the same as with an unfilled resin. This is illustrated in the examples of the present application, which contrast transparent compositions including nanoparticles with opaque compositions including microsized particles. See page 25, lines 4-10, of the present application, which notes that Examples 1-3 of the invention including nanosized particles only are transparent.

Also, the nanoparticles do not form a sediment so that composition can remain homogenous and there is no need for stirring equipment. As a non-limiting example, page 25, lines 4-10 of the present application notes that Examples 4-6 of the invention, which include nanoparticles and microparticles, remain homogeneous over a period of 6 weeks without stirring, as compared to the Comparative Example, which includes microparticles only and which forms a solid sediment after about one week.

In addition, the viscosity of the nanoparticle filled resin composition can be in the same range as an unfilled resins, which can permit the recoating step to be performed as usual. Again, reference is made to page 25, lines 4-10, of the present application, which notes that Examples 5 and 6 exhibit similar viscosities as the Comparative Example, despite higher total filler concentrations.

6. ***Grounds of Rejection to Be Reviewed on Appeal.***

Claims 1-10 and 12-21 stand rejected under 35 U.S.C. 102(b) as being anticipated by Haruta et al. (EP 0830928 B1).

Claims 1-10 and 12-21 stand rejected under 35 U.S.C. 102(b) as being anticipated by Watanabe et al. (EP 0831373 A2).

Claims 1-21 stand rejected under 35 U.S.C. 102(e) as being anticipated by Napadensky et al. (U.S. Patent Application Publication 2003/0207959 A1).

Claims 1-21 stand rejected under 35 U.S.C 103(a) as being unpatentable over Napadensky et al. (U.S. Patent Application Publication 2003/0207959 A1).

7. ***Argument.***

A. Claims 1-10 and 12-21 are patentable under 35 U.S.C. 102(b) over Haruta et al. (EP 0830928 B1).

The Examiner has taken the position that Claims 1-10 and 12-21 are anticipated by Haruta et al. Applicants respectfully submit, however, that Haruta et al. do not teach the claimed invention.

The claimed invention recites a process for forming a three-dimensional article by stereolithography including coating a thin layer of a liquid radiation-curable composition onto a surface. As recited in Claim 1, the composition includes at least one filler comprising silica-type nanoparticles. Reference is made to page 6, lines 12-15, of the present application, which defines the nanoparticles as having an average particle size ranging from about 10 to about 999 nm.

Haruta et al. do not teach the use of nanoparticles in a radiation curable composition. In contrast to the claimed invention, the Haruta et al. compositions can include filler having an average size that is significantly larger than the claimed nanoparticles. See paragraph [0062] of Haruta et al., which states that the compositions can include filler having an

average particle size of 1 to 50 μm. Nanoparticles as claimed simply are not the same as the micron sized particles of Haruta et al.

Not only are the particles of the claimed invention different from the particles of Haruta et al. The compositions of the claimed invention also differ from the compositions of Haruta et al., and the application as filed includes evidence supporting the differences in formulations that result when using nanoparticles. As an example, compositions including nanoparticles can be optically transparent. As another example, compositions including nanoparticles can remain homogeneous, even in combination with microparticles. In contrast, compositions including microparticles only can form a solid sediment. Still further, the compositions of the invention can have a viscosity in the same range as unfilled resins, despite higher total filler concentrations.

Haruta et al. differs in other respects from the claimed invention. Haruta et al. do not teach a composition including a hydroxyl-functional compound as recited in claims 18 and 21, and certainly do not teach a composition including trimethylyl propane as recited in claim 19. Haruta et al. also do not teach a hydroxyl-functional compound in an amount of about 1 to about 10% by weight as recited in claim 20, nor do Haruta et al. teach a composition include both nanoparticles and microparticles as recited in claim 21.

The standard for lack of novelty, that is, for "anticipation," is one of strict identity. To anticipate a claim for a patent, a single prior source must contain all its essential elements. Stated differently, a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Teleflex, Inc. v. Ficosa North American Corp.*, 299 F.3d 1313, 1335, 63 USPQ2d 1374 (Fed. Cir. 2002 ("As we have repeatedly stated, anticipation requires that each limitation of a claim must be found in a single reference.").

Haruta et al. do not teach stereolithographic processes using a composition including nanoparticles as claimed. In addition, Haruta et al. do not teach a composition including a hydroxyl-functional compound as recited in claims 18-21, nor do Haruta et al. teach a

composition including a combination of nanoparticles and microparticles as recited in claim 21. Accordingly, Haruta et al. do not anticipate the claimed invention.

In view of the foregoing, Applicants submit that the claimed invention is novel over Haruta et al. Applicants respectfully request that the Board reverse the anticipation rejection of Claims 1-10 and 12-21 in view of Haruta et al. and order immediate allowance of the same.

B. Claims 1-10 and 12-21 are patentable under 35 U.S.C. 102(b) over Watanabe et al. (EP 0831373 A2).

The Examiner has taken the position that Claims 1-10 and 12-21 are anticipated by Watanabe et al. (EP 0831373 A2). Applicants respectfully submit, however, that Watanabe et al. also do not teach the claimed invention.

As noted herein, the claimed invention recites a process for forming a three-dimensional article by stereolithography including coating a thin layer of a liquid radiation-curable composition onto a surface. As recited in Claim 1, the composition includes at least one filler comprising silica-type nanoparticles. Again, reference is made to page 6, lines 12-15, of the present application, which defines the nanoparticles as having an average particle size ranging from about 10 to about 999 nm.

Similar to Haruta ct al., Watanabe et al. also do not teach the use of nanoparticles in a radiation curable composition. Rather, in contrast to the claimed invention, the Watanabe et al. compositions can include filler having an average size that is significantly larger than the claimed nanoparticles. See page 7, lines 42-46, of Watanabe et al., which states that the compositions can include filler having an average particle size of 1 to 50 μm. Watanabe et al. actually teach away from the claimed invention, stating that undesirable results can occur "[i]f the average particle size is too small." Page 7, lines 43-44. Nanoparticles as claimed simply are not the same as the micron sized particles of Haruta et al.

Also as discussed above, not only are the particles of the claimed invention different from the particles of Watanabe et al. The resultant compositions are also different, and the application as filed includes evidence supporting the differences in formulations that result when using nanoparticles. As an example, compositions including nanoparticles can be optically transparent. As another example, compositions including nanoparticles can remain homogeneous, even in combination with microparticles. In contrast, compositions including microparticles only can form a solid sediment. Still further, the compositions of the invention can have a viscosity in the same range as unfilled resins, despite higher total filler concentrations.

Watanabe et al. differ in other respects from the claimed invention. For example, Watanabe et al. do not teach a composition including both nanoparticles and microparticles, such as recited in claim 21.

The standard for lack of novelty, that is, for "anticipation," is one of strict identity. To anticipate a claim for a patent, a single prior source must contain all its essential elements. Stated differently, a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Teleflex, Inc. v. Ficosa North American Corp.*, 299 F.3d 1313, 1335, 63 USPQ2d 1374 (Fed. Cir. 2002 ("As we have repeatedly stated, anticipation requires that each limitation of a claim must be found in a single reference.").

Watanabe et al. do not teach stereolithographic processes using a composition including nanoparticles as claimed. In addition, Watanabe et al. do not teach a composition including a combination of nanoparticles and microparticles as recited in claim 21. Accordingly, Watanabe et al. do not anticipate the claimed invention.

In view of the foregoing, Applicants submit that the claimed invention is novel over Watanabe et al. Applicants respectfully request that the Board reverse the anticipation rejection of Claims 1-10 and 12-21 in view of Watanabe et al. and order immediate allowance of the same.

C. Claims 1-21 are patentable under 35 U.S.C. 102(e) and 103(a) over Napadensky et al. (U.S. Patent Application Publication 2003/0207959 A1).

The Examiner has taken the position that Claims 1-21 are anticipated by or rendered obvious in view of Napadensky et al. (U.S. Patent Application Publication 2003/0207959 A1). Applicants respectfully submit, however, that Napadensky et al. do not teach or suggest the claimed invention.

The claimed invention is directed to a stereolithographic process for making three dimensional articles. Typically in stereolithography, portions of an upper surface of a liquid radiation curable resin in a vat are selectively exposed to radiation (for example, using a laser) to harden the exposed portions. A new uncured resin layer is then formed on the cured layer, for example by lowering a platform into the vat of liquid to allow fresh resin to flow onto and cover the cured resin layer. Thereafter, portions of the subsequent layer of resin are selectively exposed to radiation to cure the layer of resin and adhere the layer to the previously exposed imaged portion. These steps can be repeated as desired to build the three dimensional article.

Napadensky et al. do not teach or suggest the claimed stereolithographic process. In contrast to the claimed invention, Napadensky et al. is directed to a three dimensional printing process. Three dimensional printing differs in various respects from stereolithography, including the use of an ink jet printing head to dispense droplets of materials. Napadensky et al. discuss throughout exemplary three dimensional printing processes using ink jet printers. See, for example, paragraphs [0014], [0057], [0074], [0092], and [0094] (referring to a composition having a viscosity "compatible with ink jet printers"); paragraphs [0036-0037] (referring to a "three dimensional printing" process, including the steps of "dispensing" first and second interface materials from a "printing head"); and paragraphs [0076]-[0079] (discussing exemplary three dimensional printing systems useful in

the invention, which can include one or more printing heads including ink-jet type nozzles through which the interface material is jetted).

The Examiner refers to paragraph [0010] of Napadensky et al. to support the position that this document teaches stereolithography. Applicants respectfully submit, however, that this paragraph of Napadensky et al. discusses, by way of background only, certain compositions stated to be useful for stereolithography. This paragraph does not teach or suggest a stereolithography process as claimed using the recited composition including nanoparticles.

The claimed invention differs in other significant respects from the Napadensky et al. process. As an example, claim 21 of the present application recites a process employing both nanoparticles and microparticles. Napadensky et al. nowhere teach or suggest using a mixture of nanoparticles and microparticles as claimed. Indeed, Napadensky et al. actually teach away from this embodiment of the invention, stating that large diameter particles (> 5 microns) "are not appropriate for ink-jet applications." See paragraph [0127] of Napadensky et al. See also paragraph [0128] of Napadensky et al., which states that higher diameter particles (> 1 micron) produce viscosities that are too high for ink jet applications.

Not only do stereolithography and three dimensional printing processes differ from one another. The problems associated with each also differ. As an example, as discussed in Napadensky et al., three dimensional printing processes employ ink jet type dispensers including a plurality of nozzles through which a material is dispensed as droplets. Napadensky et al. accordingly discuss formulations suitable for use with such ink jet printer heads. This is not applicable to stereolithographic process, such as claimed in the present invention, which do not employ an ink jet printer head. As another example of the different problems associated with these processes, sedimentation of the filler can be a problem in stereolithography. Napadensky et al., however, do not recognize filler sedimentation as problem in three dimensional printing.

As noted herein, the standard for lack of novelty, that is, for "anticipation," is one of strict identity. To anticipate a claim for a patent, a single prior source must contain all its essential elements. Stated differently, a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Teleflex, Inc. v. Ficosa North American Corp.*, 299 F.3d 1313, 1335, 63 USPQ2d 1374 (Fed. Cir. 2002 ("As we have repeatedly stated, anticipation requires that each limitation of a claim must be found in a single reference.").

In addition, the law is clear that an Examiner must be able to point to something in the prior art that suggests in some way a modification of a particular reference or a combination with another reference to arrive at the claimed invention. *In re Fine*, 837 F.2d 1071, 5 USPQ 2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ 2d 1941 (Fed. Cir. 1992). The teaching or suggestion to make the claimed modification must be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Absent such a showing in the prior art, the Examiner has impermissibly used the Applicants' teaching to hunt through the prior art for the claimed elements and combine or modify them as claimed. *In re Laskowski*, 871 F.2d 115, 117, 19 USPQ 2d 1397, 1398 (Fed.Cir. 1989); s*ee also In re Fine*, 837 F.2d at 1075 ("One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.").

Stereolithography and three dimensional printing are different processes. The Napadensky et al. publication is directed to three dimensional printing and does not teach a stereolithography process as claimed. Accordingly, the claimed invention is not anticipated by Napadensky et al.

Napadensky et al. also do not suggest the claimed invention. The Napadensky et al. publication addresses different problems than the claimed invention and does not recognize the types of issues associated with stereolithography. There is no motivation to look to Napadensky et al., much less any motivation or suggestion to modify the three dimensional

printing process thereof. To conclude otherwise requires an improper hindsight analysis based upon the teachings of Applicants' own application and further requires the Examiner to improperly pick and choose among isolated disclosures of Napadensky et al. to support a conclusion of obviousness.

Further, Napadensky et al. do not teach or suggest the use of nanoparticles and microparticles as recited in claim 21, and indeed the cited document actually teaches away from this embodiment of the invention.

Inasmuch as Napadensky et al. fail to teach or suggest the claimed invention, the Examiner has failed to establish that the claimed invention is anticipated by or rendered obvious by Napadensky et al. Applicants accordingly respectfully request that the Board reverse the anticipation and obviousness rejections of Claims 1-21 in view of Napadensky et al. and order immediate allowance of the same in this case.

8. ***Claims Appendix.***

A copy of the claims involved on appeal is provided in the Appendix.

9. ***Evidence Appendix.***

There is no evidence, and therefore an Appendix setting forth evidence is not provided.

10. ***Related Proceedings Appendix.***

There are presently no related proceedings, and therefore an Appendix setting forth any related proceedings is not provided.

Respectfully submitted,

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CLAIMS APPENDIX

1. (Previously amended) A process for forming a three-dimensional article by stereolithography, said process comprising the steps:

(a) coating a thin layer of a liquid radiation-curable composition onto a surface said composition including at least one filler comprising silica-type nano-particles suspended in the radiation-curable composition:

(b) exposing said thin layer imagewise to actinic radiation to form an imaged cross-section, wherein the radiation is of sufficient intensity to cause substantial curing of the thin layer in the exposed areas;

(c) coating a thin layer of the composition onto the previously exposed imaged cross-section;

(d) exposing said thin layer from step (c) imagewise to actinic radiation to form an additional imaged cross-section, wherein the radiation is of sufficient intensity to cause substantial curing of the thin layer in the exposed areas and to cause adhesion to the previously exposed imaged cross-section;

(e) repeating steps (c) and (d) a sufficient number of times in order to build up the three-dimensional article.

2. (Previously amended) The process of claim 1 wherein the radiation-curable composition includes:

(a) at least one free-radical polymerizing organic substance;

(b) at least one free-radical polymerization initiator;

(c) at least one filler comprising silica-type nanoparticles suspended in the radiation-curable composition;

(d) optionally, at least one cationically polymerizing organic substance;

(e) optionally, at least one cationic polymerization initiator;

(f) optionally, at least one hydroxyl-functional compound; and

(g) optionally, at least one type of microparticle filler.

3. (Previously amended) The process of claim 2 wherein component (a) is at least one mono-, di-, tri-, tetra- or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic or aromatic (meth)acrylate.

4. (Original) The process of claim 2 wherein component (a) is at least one (meth)acrylate comprises a mono-, di- or tri-functional aliphatic (meth)acrylate compound.

5. (Original) The process of claim 2 wherein component (a) comprises a mono-functional aliphatic (meth)acrylate compound.

6. (Original) The process of claim 2 wherein component (a) comprises a di-functional aliphatic (meth)acrylate compound or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic, or aromatic (meth)acrylate.

7. (Original) The process of claim 2 wherein component (a) comprises a urethane (meth)acrylate.

8. (Original) The process of claim 2 wherein component (a) constitutes from about 5% to about 70% by weight of the total liquid radiation-curable composition.

9. (Original) The process of claim 2 wherein component (b) is 1-hydroxycyclohexyl phenyl ketone or 2,4,6-trimethylbenzoyldiphenylphosphine oxide or a mixture of both.

10. (Original) The process of claim 2 wherein component (b) constitutes from about 0.1 to about 7% by weight of the total liquid radiation-curable composition.

11. (Original) The process of claim 2 wherein component (c) nano-particles are spherical, have a particle size distribution of 10 to 50 nanometers, are not agglomerated, and are surface modified.

12. (Original) The process of claim 2 wherein component (c) constitutes from about 15% to about 60% by weight to the total resin composition.

13. (Original) The process of claim 2 wherein component (d) is present and comprises 3,4-epoxycyclohexylmethyl-3',4'-epoxycyclohexane carboxylate.

14. (Original) The process of claim 2 wherein component (d) is present and comprises trimethylol propane triglycidylether.

15. (Original) The process of claim 2 wherein component (d) is present and constitutes from about 10% to about 40% by weight of the total liquid radiation-curable composition.

16. (Original) The process of claim 2 wherein component (e) is present and is triarylsulfonium hexafluoroantimonate.

17. (Original) The process of claim 2 wherein component (e) is present and constitutes from about 0.1 to about 8% by weight of the total liquid radiation-curable composition.

18. (Original) The process of claim 2 wherein additionally comprising at least one (f) hydroxyl-functional compound.

19. (Original) The process of claim 18 wherein component (f) is trimethylol propane.

20. (Original) The process of claim 2 wherein component (f) is present and constitutes about 1% to about 10% by weight of the total liquid radiation-curable composition.

21. (Original) The process of claim 2 wherein the composition comprises:

(a) at least one mono-, di-, tri-, tetra- or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic or aromatic (meth)acrylate;

(b) at least one free-radical polymerization initiator;

(c) at least one filler comprising silica nanoparticles suspended in the composition;

(d) at least one cationically polymerizing organic substance selected from the group consisting of 3,4-epoxycyclohexylmethyl-3',4'-epoxy-cyclohexane carboxylate, trimethylol propane triglycidylether and mixtures thereof;

(e) at least one cationic polymerization initiator;

(f) at least one hydroxyl-functional compound; and

(g) at least one microparticle filler.

22. (Withdrawn) A solid three-dimensional article produced by the process of claim 1.

23. (Withdrawn) A liquid radiation-curable composition useful for the production of three dimensional articles by stereolithography that comprises:

(a) at least one free-radical polymerizing organic substance;

(b) at least one free-radical polymerization initiator;

(c) at least one filler comprising silica-type nanoparticles suspended in the radiation-curable composition;

(d) at least one cationically polymerizing organic substance;

(e) at least one cationic polymerization initiator;

(f) optionally, at least one hydroxyl-functional compound; and

(g) optionally, at least one type of microparticle filler.

24. (Withdrawn) The composition of claim 23 wherein component (a) is at least one mono-, di-, tri-, tetra- or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic or aromatic (meth)acrylate.

25. (Withdrawn) The composition of claim 23 wherein component (a) comprises a mono-, di- or tri-functional aliphatic (meth)acrylate compound.

26. (Withdrawn) The composition of claim 23 wherein component (a) comprises a mono-functional aliphatic (meth)acrylate compound.

27. (Withdrawn) The composition of claim 23 wherein component (a) comprises a di-functional aliphatic (meth)acrylate compound or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic, or aromatic (meth)acrylate.

28. (Withdrawn) The composition of claim 23 wherein component (a) comprises a urethane (meth)acrylate.

29. (Withdrawn) The composition of claim 23 wherein component (a) constitutes from about 5% to about 50% by weight of the total liquid radiation-curable composition.

30. (Withdrawn) The composition of claim 23 wherein component (b) is 1-hydroxycyclohexyl phenyl ketone or 2,4,6-trimethylbenzoyldiphenylphosph- ine oxide or a mixture of both.

31. (Withdrawn) The composition of claim 23 wherein component (b) constitutes from about 0.1 to about 7% by weight of the total liquid radiation-curable composition.

32. (Withdrawn) The composition of claim 23 wherein component (c) nanoparticles are spherical, have a particle size distribution of 10 to 50 nanometers, are not agglomerated, and are surface modified.

33. (Withdrawn) The composition of claim 23 wherein component (c) constitutes from about 15% to about 60% by weight to the total resin composition.

34. (Withdrawn) The composition of claim 23 wherein component (d) comprises 3,4-epoxycyclohexylmethyl-3',4'-epoxycyclohexane carboxylate.

35. (Withdrawn) The composition of claim 23 wherein component (d) comprises trimethylol propane triglycidylether.

36. (Withdrawn) The composition of claim 23 wherein component (d) constitutes from about 10% to about 40% by weight of the total liquid radiation-curable composition.

37. (Withdrawn) The composition of claim 23 wherein component (e) is triarylsulfonium hexafluoroantimonate.

38. (Withdrawn) The composition of claim 23 wherein component (e) constitutes from about 0.1 to about 8% by weight of the total liquid radiation-curable composition.

39. (Withdrawn) The composition of claim 23 wherein additionally comprising at least one (f) hydroxyl-functional compound

40. (Withdrawn) The composition of claim 23 wherein component (f) is trimethylol propane.

41. (Withdrawn) The composition of claim 23 wherein component (f) is present from about 1% to about 10% by weight of the total liquid radiation-curable composition.

42. (Withdrawn) The composition of claim 23 wherein the composition comprises:

(a) at least one mono-, di-, tri-, tetra- or pentafunctional monomeric or oligomeric aliphatic, cycloaliphatic or aromatic (meth)acrylate;

(b) at least one free-radical polymerization initiator;

(c) at least one filler comprising silica nanoparticles suspended in the composition;

(d) at least one cationically polymerizing organic substance selected from the group consisting of 3,4-epoxycyclohexylmethyl-3',4'-epoxy-cyclohexane carboxylate, trimethylol propane triglycidylether and mixtures thereof;

(e) at least one cationic polymerization initiator;

(f) at least one hydroxyl-functional compound; and

(g) at least one microparticle filler.